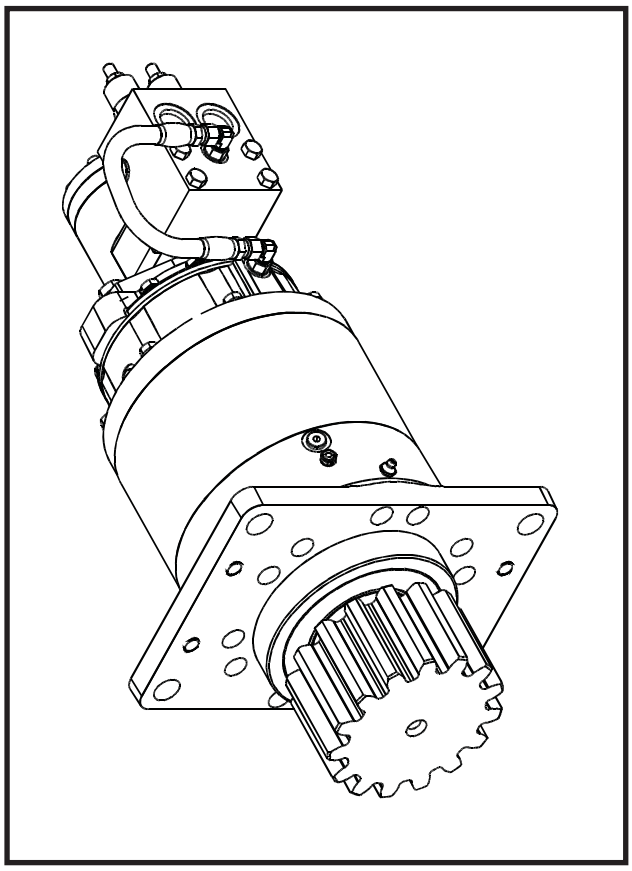
BRADEN

SD40

HYDRAULIC SWING DRIVE
SERVICE AND MAINTENANCE MANUAL



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INTRODUCTION

Read and understand this entire manual before servicing your Braden planetary drive. Retain this manual for future reference.

The following service instructions have been prepared to provide assembly, disassembly and maintenance information for the Braden SD40 planetary drives. Before doing any work on these units, all assembly and disassembly instructions should be read and understood.

If a question arises regarding your Braden drive or this manual, please contact:

Braden Service Department
PO Box 547
Broken Arrow, Oklahoma 74013
United States
Tel.918-251-8511
Fax.918-259-1575
Monday-Friday, 8:00 am to 4:30 pm CST
www.paccarwinch.com.

Provide the complete drive model and serial number when making inquiries.

Safety informational callouts in this manual include:

⚠ WARNING ⚠

Warning – This emblem is used to warn against hazards and unsafe practice which could result in severe personal injury or death if proper procedures are not followed.

⚠ CAUTION ⚠

Caution – This emblem is used to warn against potential or unsafe practices which could result in personal injury or property damage if proper procedures are not followed.

GENERAL SAFETY RECOMMENDATIONS

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the prime mover and drive unit must be operated with care and concern by the operator of the equipment, and the operator should have a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.

⚠ WARNING ⚠

Failure to obey the following safety recommendations may result in property damage, personal injury, or death.

1. Read all warning tag information and become familiar with all controls before operating equipment.
2. Never attempt to clean, oil, or perform any maintenance on a machine with the engine running, unless instructed to do so in the service manual.
3. Never operate the drive controls unless you are properly seated at the operator's station on the prime mover and you are sure ground personnel are clear of the work area.
4. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
5. Ground personnel should stay in view of the prime mover operator at all times.
6. On machines having hydraulically, mechanically, and/or cable controlled equipment, be certain the equipment is either lowered to the ground or blocked securely before servicing, adjusting and/or repairing the drive. Always apply the prime mover parking brakes before dismounting the prime mover.
7. Keep equipment in good operating condition. Perform scheduled servicing listed in the "Preventive Maintenance" section of this manual.
8. Do not weld on any part of the drive.
9. Use recommended hydraulic oil and gear lubricant.
10. Keep hydraulic system clean and free from contamination at all times.
11. Never allow anyone to stand under a suspended load.
12. Any hoist, lifting device, chains, or slings must be rated in excess of the load being handled and must be in good repair and/or good operating condition.
13. Use extreme care when operating a press to assemble or disassemble component parts. All parts must be held securely to avoid sudden unexpected movement.
14. When handling hot or cold parts, or draining hot oil, always wear gloves for personal protection.
15. Always use appropriate personal safety equipment such as safety glasses, hard hat, safety shoes, and gloves

EXPLANATION OF MODEL NUMBER

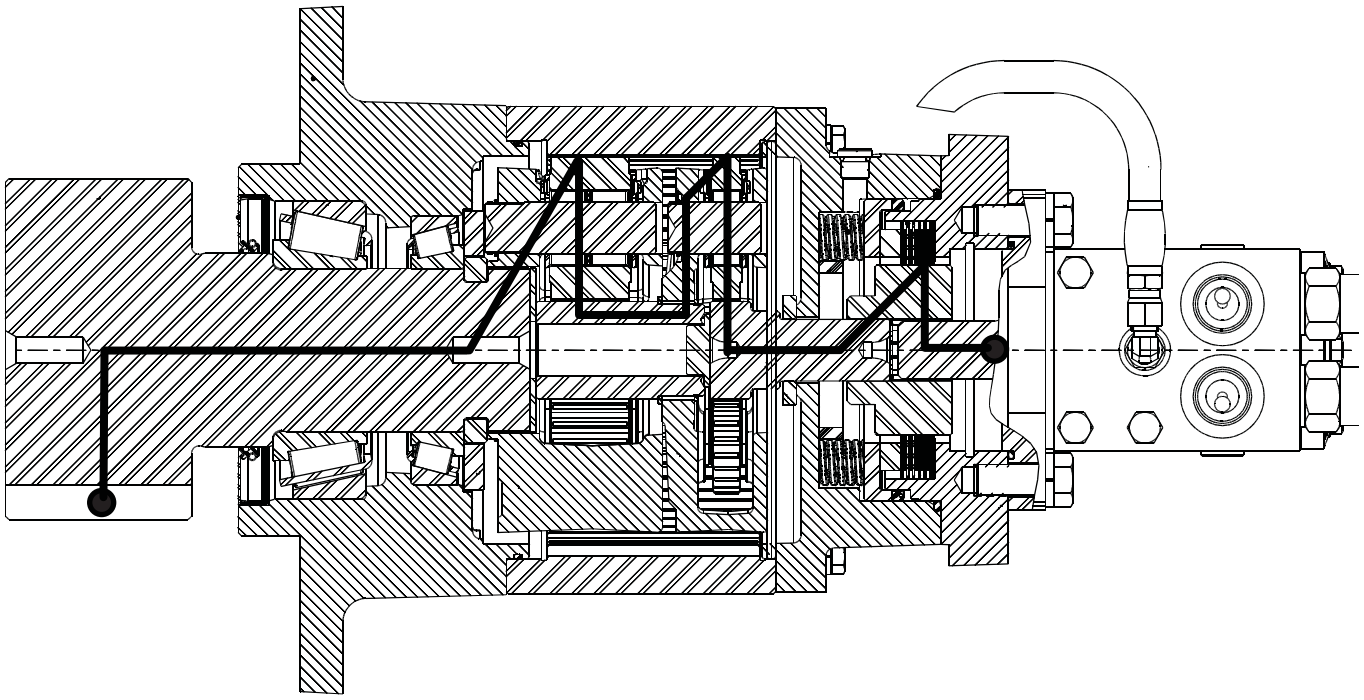
SD40 B - 34/ 45 - 05706

SD - DESIGNATES GEARMATIC HOIST
40 - TORSIONAL TORQUE OUTPUT
B - EVOLUTIONARY DESIGNATION
34 - TOTAL GEAR REDUCTION (34:1)
45 - MOTOR DISPLACEMENT (4.5 CU. IN/rev)
05706 - BRADEN PART NUMBER

GENERAL INFORMATION

SD40 planetary drives have 2 planet sets. On all units, the ring gear is held stationary and the primary reduction is closest to the motor. Power is transmitted progressively from one planet set to the next, with the output pinion driven by the final planet carrier. The planet gears run on loose roller bearings.

A Braden manufactured brake is mounted between the motor and gearbox. These brakes are multi-disc, spring applied and hydraulically released. The brake contains a solid input hub which couples it to the input sun gear. Brakes with a solid hub are effective in both directions and must be hydraulically released for the motor to turn in either direction. The brake is lubricated by the oil in the gearbox.



PREVENTATIVE MAINTENANCE AND SPECIFICATIONS

Oil Level

Standard Installation
The standard installation of the unit is in a vertical position with the output pinion up. The oil level plug is located on the bearing carrier next to the vent, and the gearbox should be filled to this level.

In general terms, the oil level should be just below the centerline if the unit is mounted horizontally, and just above the bottom of upper planetary gear set if the unit is mounted vertically (motor end up). The oil level should be checked monthly under normal operating conditions and weekly under extreme operating conditions.

Oil Change

Intermittent Duty Cycle
(i.e. track drive and crane turret drive applications)

The gear oil should be changed after the first 200 hours of machine operation, then every 1,000 hours thereafter.

High Duty Cycle
(i.e. reducer drive applications)

The gear oil should be changed after the first 50 hours of machine operation, then every 500 hours thereafter.

At each oil change, the oil should be checked for obvious signs of internal wear or damage (i.e. large or excessive amounts of metallic shavings). Note that during the initial operation of the gearbox, a small amount of metallic filings is normal as the gears wear in.

Vent Plug

The vent plug is located on the bearing carrier housing. It is very important to keep this vent clean and unobstructed. Whenever gear oil is changed, remove the vent plug, clean it in solvent and reinstall.

Do not paint over the vent or replace it with a solid plug.

Grease Output Pinion Bearings

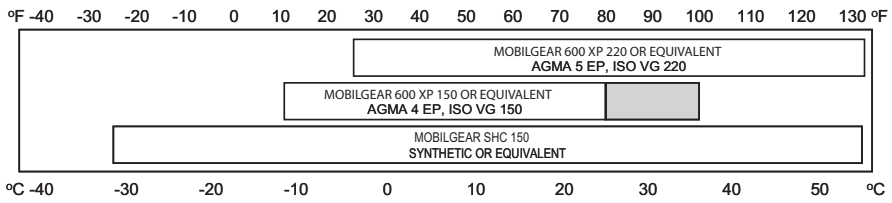
(Pinion Up Units Only) Refer to the drawing on page 12.

Every 50 hours of operation remove the vent plug #8 shown and the oil level plug #9 on the cross section. With a hand pump SLOWLY pump grease into the bearing cavity grease fitting.

(Installing grease quickly can build up local pressures which COULD cause the seal to be pushed out of position.) Use NLGI #2 EP (extreme pressure) grease with a Lithium Complex base that meets NLGI GC or GC/LB requirements. Monitor the open holes. When oil / grease starts coming out either open port – stop pumping. Use a tool (not your finger) to clean out the holes as much as possible so that grease does not plug the vent. Reinsert the plug & vent.

RECOMMENDED PLANETARY GEAR OIL

PREVAILING AMBIENT TEMPERATURE


ºF -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 ºF
MOBILGEAR 600 XP 220 OR EQUIVALENT
AGMA 5 EP, ISO VG 220
MOBILGEAR 600 XP 150 OR EQUIVALENT
AGMA 4 EP, ISO VG 150
MOBILGEAR SHC 150
SYNTHETIC OR EQUIVALENT
ºC -40 -30 -20 -10 0 10 20 30 40 50 ºC

NOTE: *SHADED TEMPERATURE RANGE IN THE CHART ABOVE NOT RECOMMENDED FOR SEVERE APPLICATIONS SUCH AS: OFFSHORE CRANES, SUSTAINED FAST DUTY CYCLES OR FREQUENT LIFTING.*

Planetary hoists are factory filled with Mobilgear 600 XP 150, or equivalent. Consult your oil supplier for other equivalent oils if required.

Mobil	Shell	Chevron	Texaco
Mobilgear 600 XP 150	Omala 150	Gear Compounds EP 150	Meropa 150
Mobilgear 600 XP 220	Omala 220	Gear Compounds EP 220	Meropa 220

⚠ CAUTION ⚠

Use only the oils listed above or equivalents. **DO NOT** use oils with a high concentration of extreme pressure additives such as those rated by API as GL5 gear oils.

Oil Capacity in vertical mount – 2.5 pints

NOTE: Oil capacity is approximate. Fill unit with oil until it runs out the level plug.

Gearbox Specifications

Ratio – 33.8:1; Output Torque – 40,000 in•lbs (4520 N•m)

RECOMMENDED FASTENER TORQUE

Higher or lower torques for special applications will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated torque values based on use of SAE 30wt engine oil applied to threads and face of bolt or nut.

Avoid using thread lubricants as the applied torque may vary by 10-40% depending upon product used.

		Torque (LB-FT)			
Bolt Dia.	Thds Per	Grade 5		Grade 8	
Inches	Inch	Dry	Lubed	Dry	Lubed
1/4	20 28	8	6	12	9
5/16	18 24	17	13	24	18
3/8	16 24	31	23	45	35
7/16	14 20	50	35	70	50
1/2	13 20	75	55	110	80
9/16	12 18	110	80	150	110
5/8	11 18	150	115	210	160

		Torque (LB-FT)			
Bolt Dia.	Thds Per	Grade 5		Grade 8	
Inches	Inch	Dry	Lubed	Dry	Lubed
3/4	10 16	265	200	380	280
7/8	9 14	420	325	600	450
1	8 14	640	485	910	680
1 1/8	7 12	790	590	1290	970
1 1/4	7 12	1120	835	1820	1360
1 3/8	6 12	1460	1095	2385	1790
1 1/2	6 12	1940	1460	3160	2370

SERVICE PRECAUTIONS

Before any part is removed from the gearbox, all service instructions should be read and understood.

Work in a clean, dust free area as cleanliness is of utmost importance when servicing hydraulic equipment.

Inspect all replacement parts prior to installation, to detect any damage which might have occurred in shipment.

Use only genuine BRADEN replacement parts for optimum results. Never re-use expendable parts such as o-rings and oil seals.

Inspect all machined surfaces for excessive wear or damage; before reassembly operations are begun.

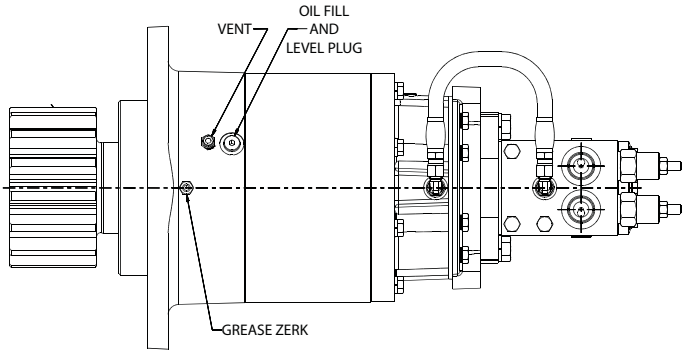
Lubricate all o-rings and oil seals with gear oil prior to installation.

Use a sealing compound on the outside surface of oil seals and a light coat of thread sealing compound on pipe threads. Avoid getting sealing compound inside parts or passages which conduct oil.

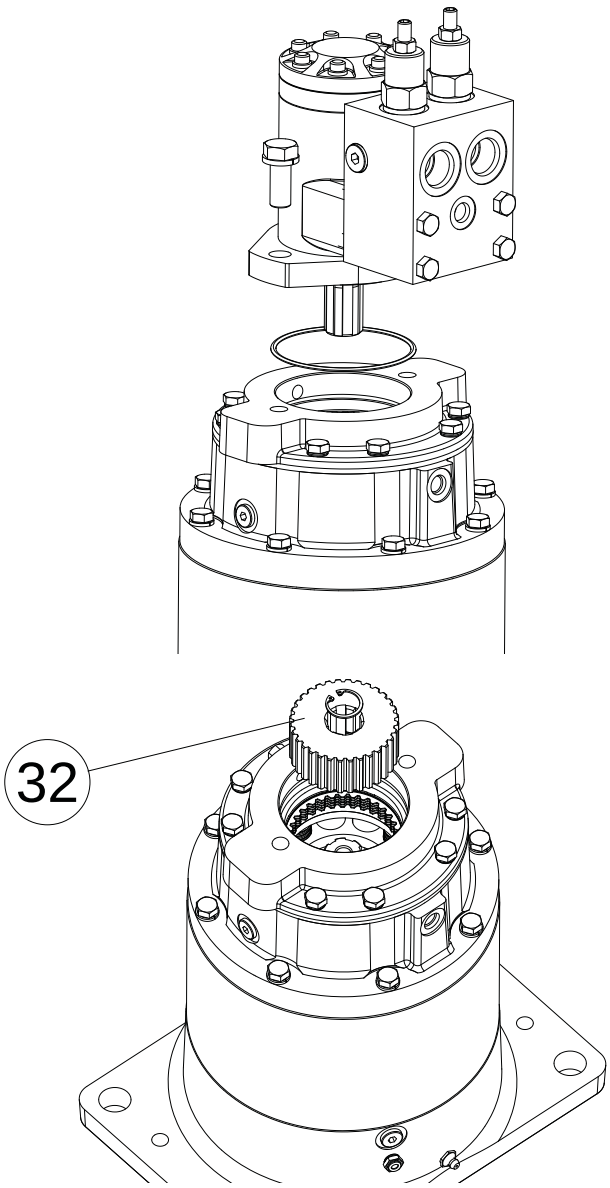
GEARBOX DISASSEMBLY

Before beginning to disassemble the gearbox, drain the oil and clean the outside surfaces to avoid contaminating the gears and bearings. Adequately support the gearbox with the input section facing up. Refer to Figure 1 on page 10 for item number reference.

Alignment marks made at the bolted connections on the drive before disassembly will aid aligning the drive sections during reassembly.

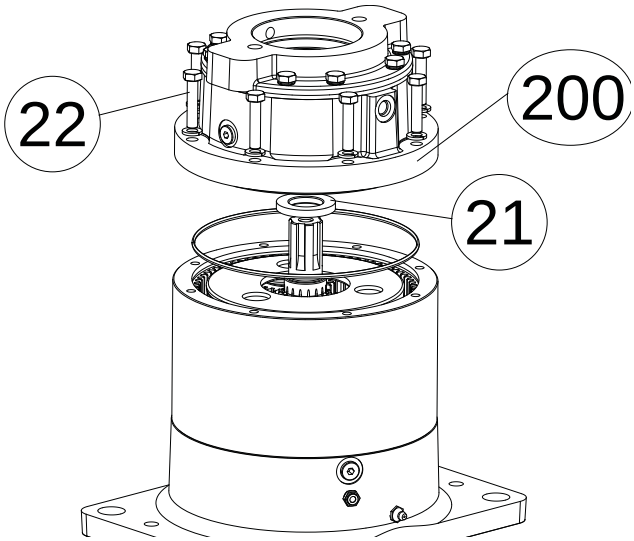


1. Drain the oil and clean the outside surfaces of the gearbox. Set the gearbox with the input/motor side up on a work bench and use wood blocks under the flange of the bearing carrier (606) to stabilize it on the workbench.

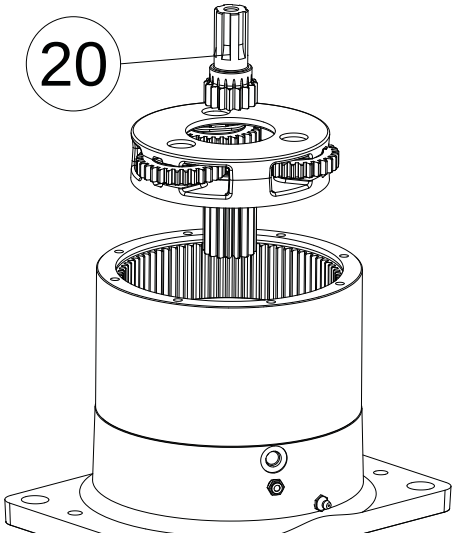


2. Disconnect the brake release hose at the gearbox. Unbolt and remove the hydraulic motor from the gearbox. Remove the brake hub (32) and remove and discard the motor pilot o-ring.

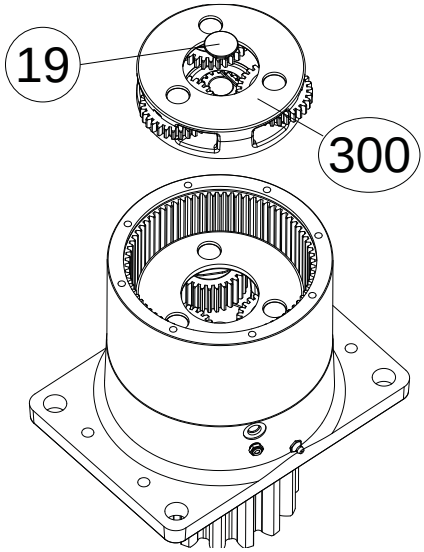
Note: A complete cross-section with item callouts can be found on page 12 of this manual



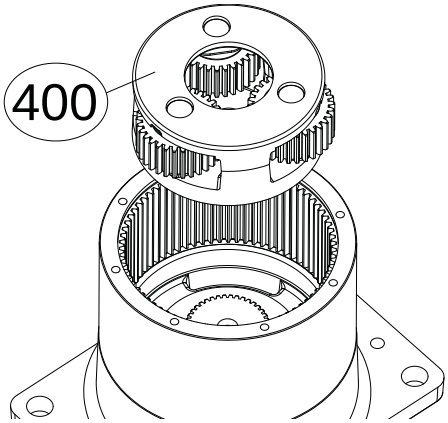
3. Remove the complete brake cylinder assembly (200) by removing the eight metric bolts (22) and lifting the brake cylinder off of the ring gear. See Brake Cylinder Service section in this manual for procedure to disassembly the brake cylinder assembly.



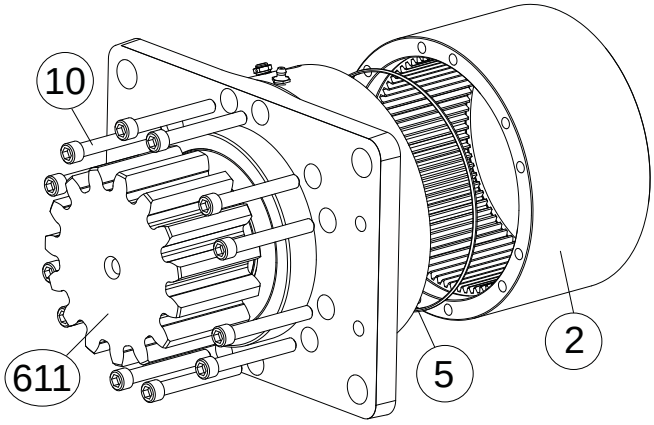
4. Remove the primary sun gear (20) and the thrust washer (21).



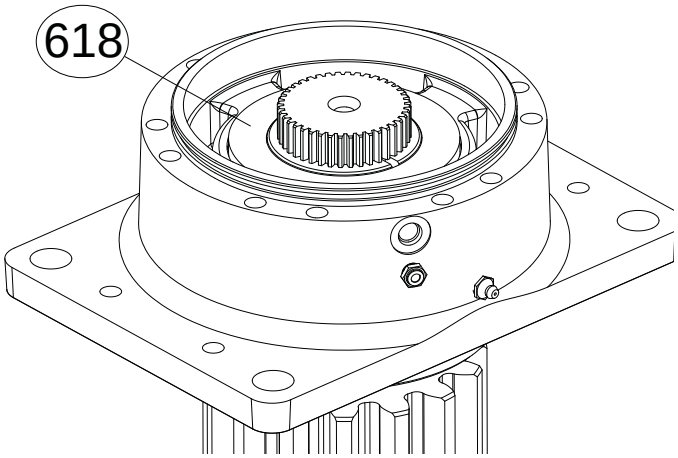
5. Remove the primary planet carrier assembly (300) and thrust plug (19).



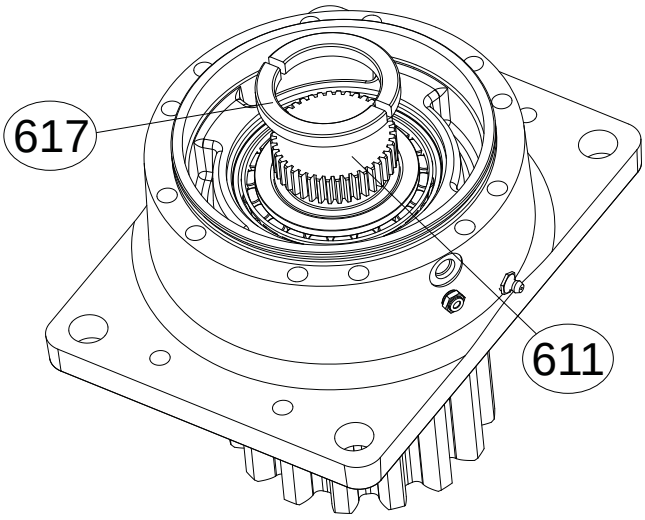
6. Remove the secondary planet carrier assembly (400.)



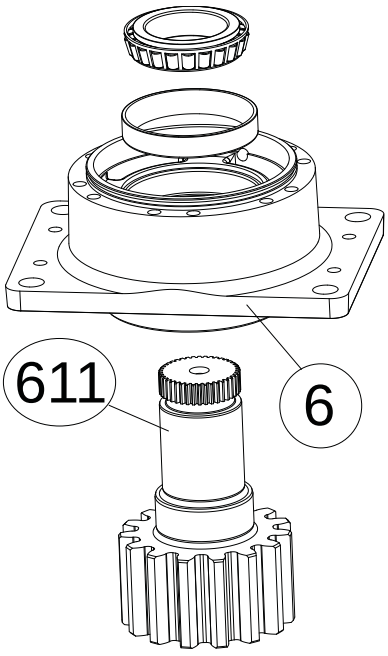
7. If the output pinion (611) will be removed, remove the ring gear (2) from the bearing carrier by removing the metric socket head capscrews (10) and discard the ring gear o-rings (5).



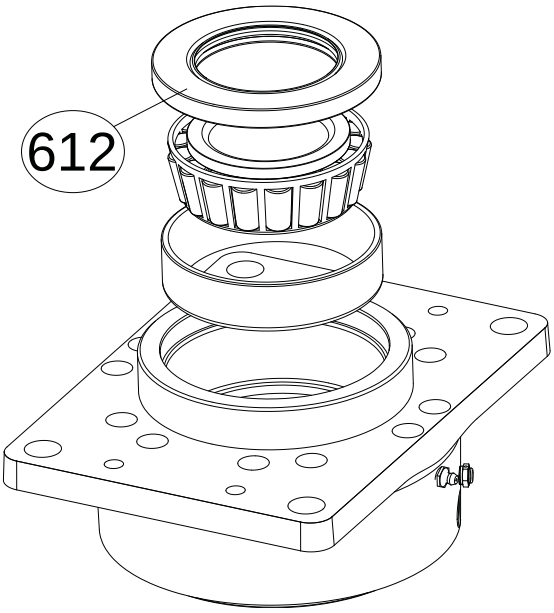
8. Remove the split ring retainer (18).



9 Take care not to damage the ground surface of the split ring halves. Use a hammer and punch to remove the split ring halves (17) from the output pinion (11).



10. Remove output pinion form bearing carrier (6).



11. Remove the output pinion seal (612).

12. Wash and inspect the bearings, planet carriers, and ring gear.

GEARBOX ASSEMBLY

1. Verify that the bearing cups (614 and 616) are installed in the bearing carrier (606). Pack the tapered roller bearings (613 and 615) with grease.

2. Place the bearing carrier (606) on a workbench with the output pinion side facing up. Set bearing cone (613) in bearing cup (615).

3. Lubricate the outside diameter of lip seal (612) with Loctite Aviation Gasket Sealant or equivalent and install lip seal in bearing carrier.

4. Lubricate output pinion bearing and seal surfaces with grease and install output pinion in bearing carrier taking care not to damage the lip seal.

5. Position bearing carrier on the workbench with the pinion down and place wood blocks under bearing carrier to stabilize unit. Install bearing cone (615) over pinion and in bearing housing. Install split rings (617) in pinion shaft and then install split ring retainer (618).

6. Install o-ring (5) into bearing carrier groove and lubricate lightly. Ensure the mating horizontal surfaces on bearing carrier (606) and ring gear (2) are clean and free of any lubricants.

7. Position ring gear onto bearing carrier. Apply Loctite 242 to capscrews (10) and torque to 60 ± 5 lb•ft (81 ± 7 N•m).

8. Install output planet carrier assembly (400) into ring gear and lower onto the output pinion ensuring that the carrier splines engage with the pinion.

9. Install the primary planet carrier assembly (300) into the ring gear. The output sun gear is retained on the primary planet carrier and engages with the output carrier assembly planet gears.

10. Install the thrust plug (19) and then the primary sun gear (20) into the primary planet carrier assembly (300). Install the thrust washer (21) onto the primary sun gear (20)

11. Install o-ring (5) into groove on brake housing (224) and lubricate lightly.

12. Slowly lower the brake cylinder assembly onto ring gear and verify proper alignment. Install lockwashers (24) and capscrews (22) and torque specified value in torque table.

13. Install internal snap ring (33) in brake hub (32). Install brake hub in brake cylinder and ensure the internal snap ring is seated on the input sun gear (20). If the friction brake plate splines are not aligned, the brake cylinder must be pressurized to install the brake hub.

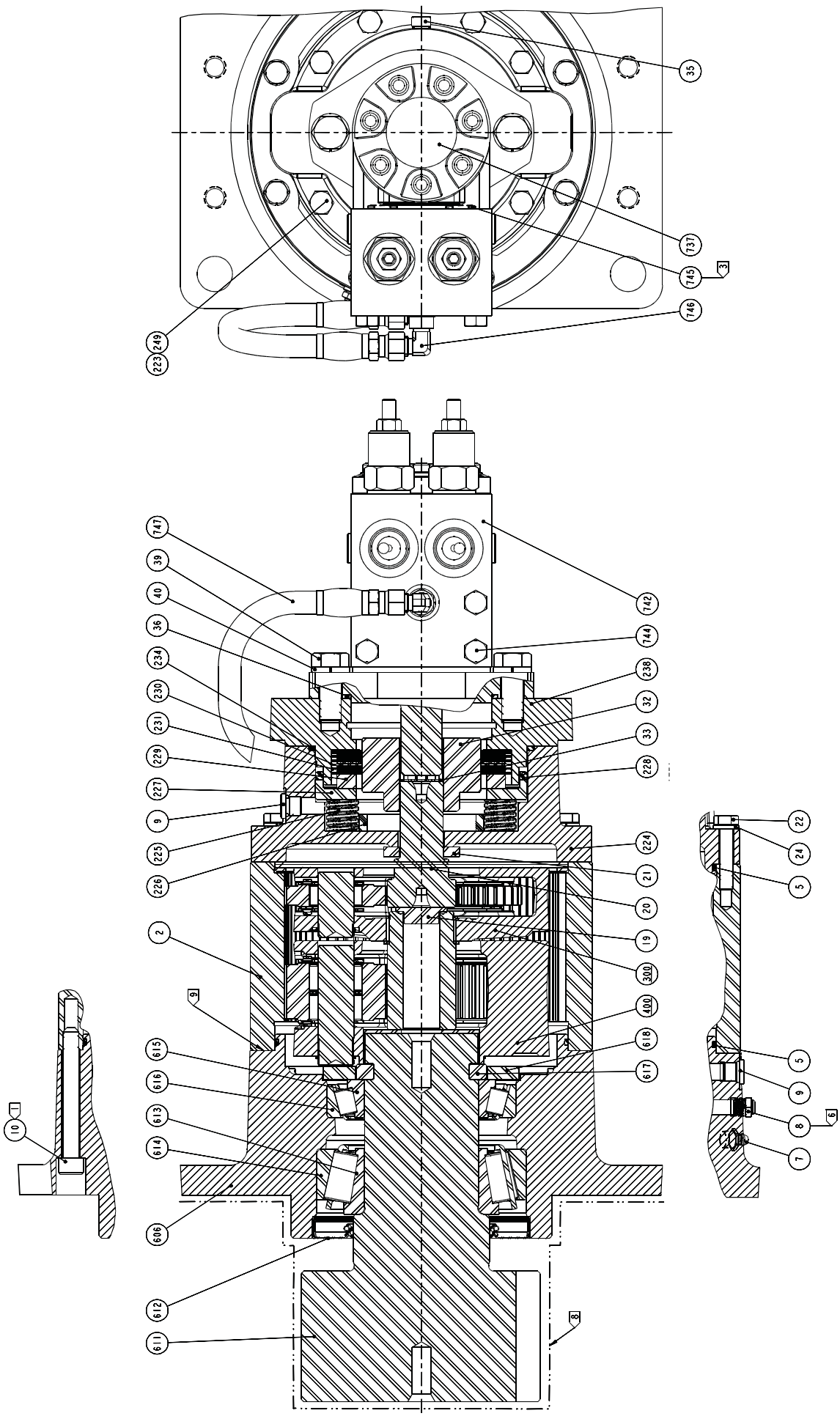
14. Install the hydraulic motor (742) in the brake cylinder assembly aligning the motor splines with the inner race of the brake hub (32). Install hydraulic motor lockwashers (40) and capscrews (39) and torque to torque table value.

15. Install o-rings (745) in brake valve (742) and bolt the brake valve to the hydraulic motor using capscrews (744). Torque to value in torque table.

16. Connect brake release hose (747) to fittings on the hydraulic motor and brake valve.

17. Operate the unit at no load while monitoring the gearbox for abnormal noises and oil leaks. Correct any abnormal condition before returning the gearbox to service.

Assembly cross-section on reverse page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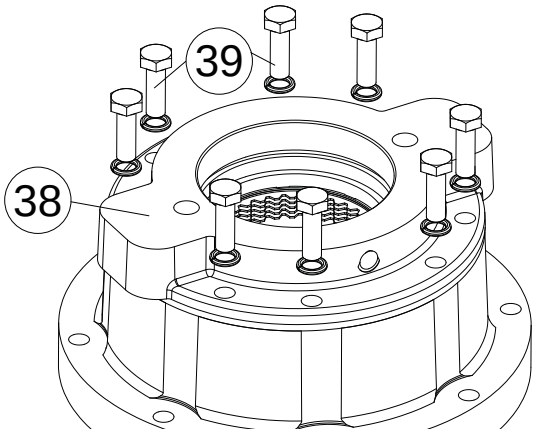
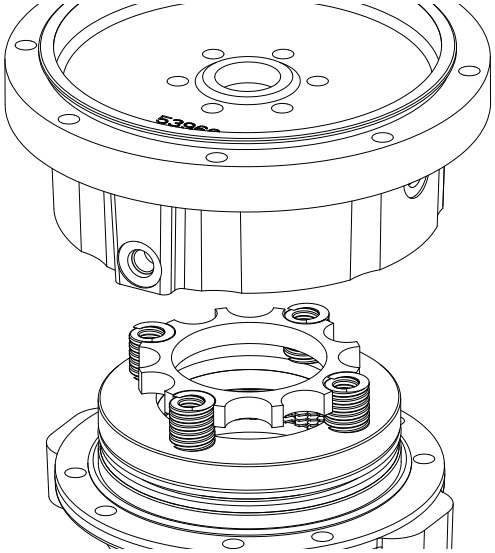
BRAKE CYLINDER SERVICE

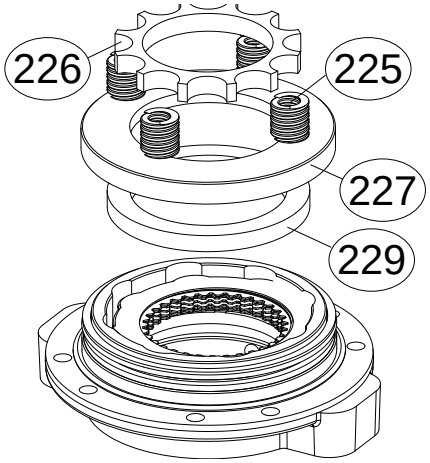
Disassembly

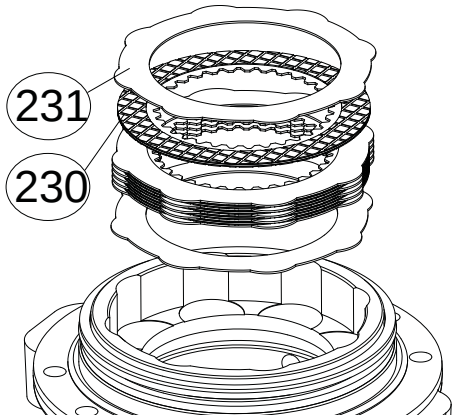


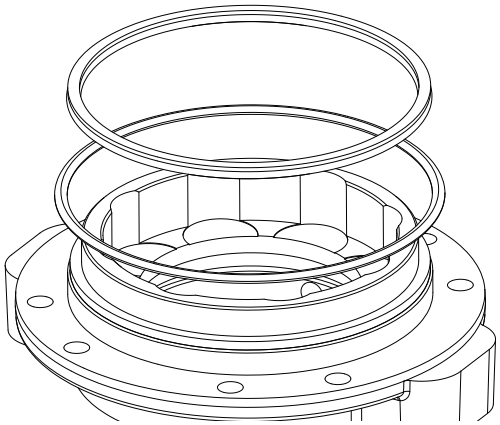
1. The force of the brake springs is applied to the motor adapter (38), so loosen the metric capscrews (39) 1 turn at a time, alternating across the gearbox, until the spring force is released. Remove the motor adapter and discard o-ring (234).



2. Continue disassembly removing spacer (229), friction discs (230), brake discs (231), U-cup seal (228), pressure plate (227), springs (225), and spring locator (226).







Clean and Inspect

1. Thoroughly clean and inspect all parts. Check brake piston sealing surfaces for wear on the brake cylinder and motor support. Ensure the brake release port is free of contamination.
2. Place friction disc on a flat surface and check for distortion with a straight edge. Friction material should appear even across the entire surface with the groove pattern visible. Replace friction disc if splines are worn to a point, disc is distorted, friction material is worn unevenly, or groove pattern is worn away.
3. Place steel brake disc on a flat surface and check for distortion with a straight edge. Inspect surface for signs of material transfer or discoloration due to heat damage. Replace disc if discolored, distorted, or if material is deformed on the outer edges at point of contact with the brake housing.
4. Inspect brake springs for any signs of cracking or distortion. If a brake spring is defective, ALL brake springs must be replaced.

⚠ CAUTION ⚠

Failure to replace springs as a set may result in uneven brake application force and repeated brake spring failure.

BRAKE CYLINDER SERVICE

Assembly

> **⚠ CAUTION ⚠**
>
> The number of steel discs, friction discs, and brake springs is listed on the material list. SD40 gearboxes are used in several applications with different brake requirements, so it is critical to reference the unit's material list for this information.

1. Begin assembly by placing the motor adapter on a workbench with the motor mounting surface down. Install a new o-ring (230).

2. Refer to the gearbox material list for the number of steel discs and friction discs needed. Lubricate the friction discs with the gearbox oil. The brake stack will alternate steel and friction discs ending with steel disc on one end and a friction disc on the opposite end. Any additional steel discs are the first discs put into the motor adapter. The brake stack is then installed in the motor adapter beginning with a friction disc and alternating until the final steel disc is installed. Place the spacer (229) on top of the top steel disc.

3. Lubricate the brake piston u-cup seal (228) and the motor adapter sealing surface with petroleum jelly or hydraulic oil. Install the brake piston seal onto the motor support with the seal lip down.

4. Place the brake housing (224) on the workbench and place the spring locator in the housing. Refer to the unit material list for the required number of springs (225). Space the required number of springs evenly around the outside diameter of the spring locator.

5. Install the spring pressure plate (227) on top of the springs in the brake housing. The close fitting spring pressure plate may be depressed at a slight angle to lodge it into the brake housing which will hold the parts in place while the brake housing is lowered onto the motor adapter.

6. Apply petroleum jelly, grease, or hydraulic oil to the mating surfaces of the o-ring and seal on the motor adapter. Install the brake housing over the motor adapter carefully to avoid damaging the seal and o-ring.

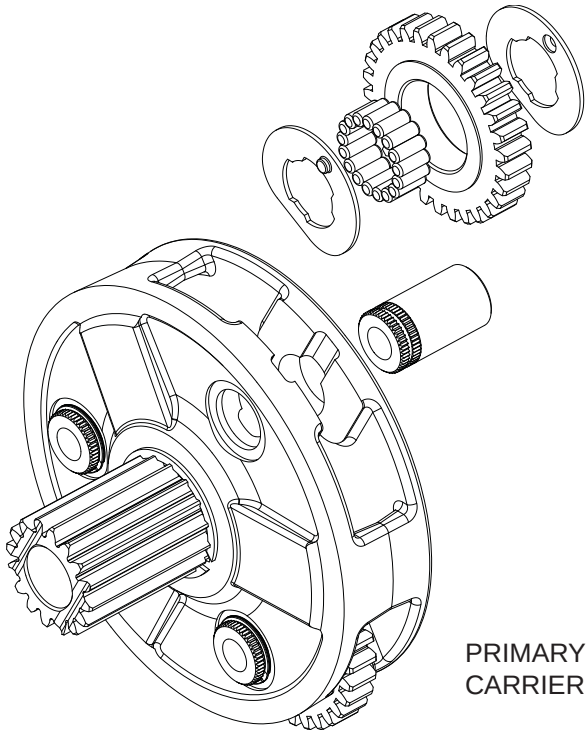
7. Install motor adapter capscrews and tighten each bolt one turn at a time in a crossing pattern to keep motor adapter level as springs are compressed. Torque to chart level; chart located on page 7.

BRAKE CYLINDER PRESSURE TEST

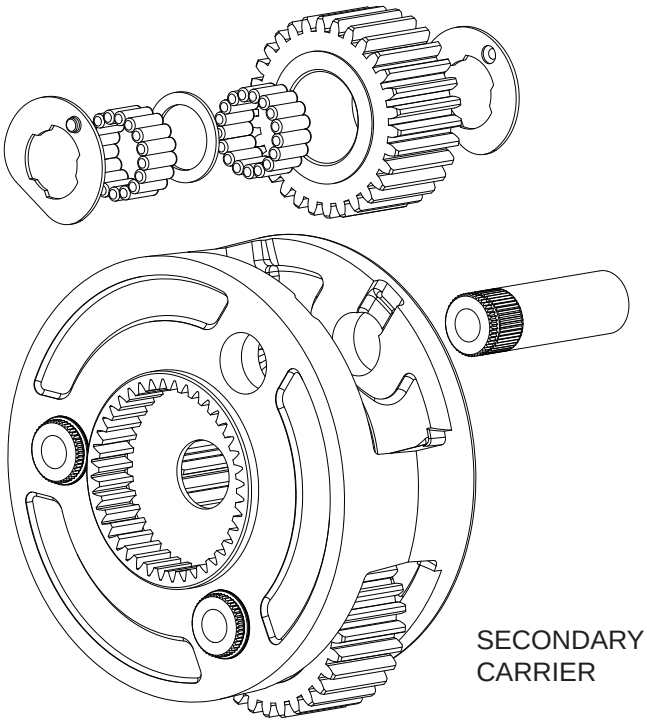
1. Connect a hydraulic hand pump with an accurate gauge and shut-off valve to the brake release port of the brake cylinder. Apply 500 psi to the brake. Close the shut-off valve and let stand for five (5) minutes. If there is any loss of pressure in five (5) minutes, the brake cylinder should be disassembled for inspection of the sealing surfaces and o-rings. (See the following step before releasing brake pressure.)

2. WHILE PRESSURE IS APPLIED AND THE BRAKE IS RELEASED, install the brake hub assembly. Rotate the clutch back and forth to align the outer race splines with the brake disc splines. Release the pressure on the brake cylinder and remove the brake hub and hand pump. The brake assembly is now complete and ready to be assembled with the main ring gear.

PLANET ASSEMBLY SERVICE



PRIMARY CARRIER



SECONDARY CARRIER

The primary planet carrier assembly has one row of loose roller bearings under the planet gears, while the output carrier has two rows of loose rollers under each gear.

The planet carrier assemblies should not be disassembled unless damage is suspected.

Disassembly

1. Remove the retaining ring from the knurled end of the planet shaft. Support the planet carrier assembly and press out each planet pin by applying force at the knurled end. Place a container under the press to catch any rollers that might come out with the planet pin.
2. Slide the planet gear and its bearings out of the carrier, being careful not to drop all the loose rollers.
3. Remove the rollers from the planet gear.
   NOTE: *The output planet assembly has two rows of loose rollers separated by a spacer.*
4. Remove the two thrush washers from the planet carrier.
5. Repeat steps 1 through 4 for each of the remaining planet gears.

   Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should be examined for any signs of spalling, corrosion, discoloration, material displacement or abnormal wear. Gears should be inspected for abnormal wear or pitting and replaced as necessary. Inspect machined surfaces and bearing bores for signs of damage or excessive wear.

Assembly

1. Liberally coat the bore of a planet gear with general purpose oil soluble grease.
2. Set a thrust washer on a clean flat work surface. Set a planet gear on its side centered over the thrust washer so the bearing rollers can be installed and the assembly slid off into the planet carrier.
3. Install a row of rollers around the bottom of the planet gear bore. Coat the rollers with a small amount of grease if necessary to hold them in place.

   Step 4 applies only to the output planet assemblies.
4. Install a bearing spacer on top of the rollers and put another row of rollers on top of the spacer.
5. Put the other thrust washer on top of the planet gear and slide the completed planet gear and bearing assembly into place in the planet carrier aligning the thrust washer knubs with the planet carrier slots. Align the roller bearings with one of the planet gear shaft holes.
6. Install a planet gear shaft through the planet carrier and bearings. Use a press to push the knurled surface through the carrier until the retaining ring groove is visible.
7. Install the retaining ring on the planet pin.
8. Repeat steps 1 through 7 for the remaining planet gears.

METRIC CONVERSION TABLE

English to Metric			Metric to English		
LINEAR					
inches (in.)	X 25.4	= millimeters (mm)	millimeters (mm)	X 0.3937	= inches (in.)
feet (ft.)	X 0.3048	= meters (m)	meters (m)	X 3.281	= feet (ft.)
miles (mi.)	X 1.6093	= kilometers (km)	kilometers (km)	X 0.6214	= miles (mi.)
AREA					
inches ^{2} (sq.in.)	X 645.15	= millimeters ^{2} (mm ^{2})	millimeters ^{2} (mm ^{2})	X 0.000155	= inches ^{2} (sq.in.)
feet ^{2} (sq.ft.)	X 0.0929	= meters ^{2} (m ^{2})	meters ^{2} (m ^{2})	X 10.764	= feet ^{2} (sq.ft.)
VOLUME					
inches ^{3} (cu.in.)	X 0.01639	= liters (l)	liters (l)	X 61.024	= inches ^{3} (cu.in.)
quarts (qts.)	X 0.94635	= liters (l)	liters (l)	X 1.0567	= quarts (qts.)
gallons (gal.)	X 3.7854	= liters (l)	liters (l)	X 0.2642	= gallon (gal.)
inches ^{3} (cu.in.)	X 16.39	= centimeters ^{3} (cc)	centimeters3 (cc)	X 0.06102	= inches ^{3} (cu.in.)
feet ^{3} (cu.ft.)	X 28.317	= liters (l)	liters (l)	X 0.03531	= feet ^{3} (cu.ft.)
feet ^{3} (cu.ft.)	X 0.02832	= meters ^{3} (m ^{3})	meters3 (m3)	X 35.315	= feet ^{3} (cu.ft.)
fluid ounce (fl.oz.)	X 29.57	= millileters (ml)	milliliters (ml)	X 0.03381	= fluid ounce (fl.oz.)
MASS					
ounces (oz.)	X 28.35	= grams (g)	grams (g)	X 0.03527	= ounces (oz.)
pounds (lbs.)	X 0.4536	= kilograms (kg)	kilograms (kg)	X 2.2046	= pounds (lbs.)
tons (2000 lbs.)	X 907.18	= kilograms (kg)	kilograms (kg)	X 0.001102	= tons (2000 lbs.)
tons (2000 lbs.)	X 0.90718	= metric tons (t)	metric tons (t)	X 1.1023	= tons (2000 lbs.)
tons (long) (2240 lbs.)	X 1013.05	= kilograms (kg)	kilograms (kg)	X 0.000984	= tons (long) (2240 lbs.)
PRESSURE					
inches Hg (60 °F)	X 3600	= kilopascals (kPa)	kilopascals (kPa)	X 0.2961	= inches Hg (60 °F)
pounds/sq.in. (PSI)	X 6.895	= kilopascals (kPa)	kilopascals (kPa)	X 0.145	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.0703	= kilograms/sq.cm. (kg/cm ^{2})	kilograms/sq.cm. (kg/cm2)	X 14.22	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.069	= bars	bars	X 14.5	= pounds/sq.in. (PSI)
inches H $_2$O (60 °F)	X 0.2488	= kilopascals (kPa)	kilopascals (kPa)	X 4.0193	= inches H $_2$O (60 °F)
bars	X 100	= kilopascals (kPa)	kilopascals (kPa)	X 0.01	= bars
POWER					
horsepower (hp)	X 0.746	= kilowatts (kW)	kilowatts (kW)	X 1.34	= horsepower (hp)
ft.-lbs./min.	X 0.0226	= watts (W)	watts (W)	X 44.25	= ft.-lbs./min.
TORQUE					
pound-inches (in.-lbs.)	X 0.11298	= newton-meters (N-m)	newton-meters (N-m)	X 8.851	= pound-inches (in.lbs.)
pound-feet (ft.-lbs.)	X 1.3558	= newton-meters (N-m)	newton-meters (N-m)	X 0.7376	= pound-feet (ft.-lbs.)
pound-feet (ft.-lbs.)	X .1383	= kilograms/meter (kg-m)	kilogram/meter (kg-m)	X 7.233	= pound-feet (ft.-lbs.)
VELOCITY					
miles/hour (m/h)	X 0.11298	= kilometers/hour (km/hr)	kilometers/hour (km/hr)	X 0.6214	= miles/hour (m/h)
feet/second (ft./sec.)	X 0.3048	= meter/second (m/s)	meters/second (m/s)	X 3.281	= feet/second (ft./sec.)
feet/minute (ft./min.)	X 0.3048	= meter/minute (m/min)	meters/minute (m/min)	X 3.281	= feet/minute (ft./min.)

TEMPERATURE

°Celsius = 0.556 (°F - 32) °Fahrenheit = (1.8 X °C) + 32

COMMON METRIC PREFIXES

mega	(M)	= 1,000,000 or 10 ^{6}	deci	(d)	= 0.1 or 10 $^{-1}$
kilo	(k)	= 1,000 or 10 ^{3}	centi	(c)	= 0.01 or 10 $^{-2}$
hecto	(h)	= 100 or 10 ^{2}	milli	(m)	= 0.001 or 10 $^{-3}$
deka	(da)	= 10 or 10 ^{1}	micro	(μ)	= 0.000.001 or 10 $^{-6}$